SD11
.A1
A42
no. 145

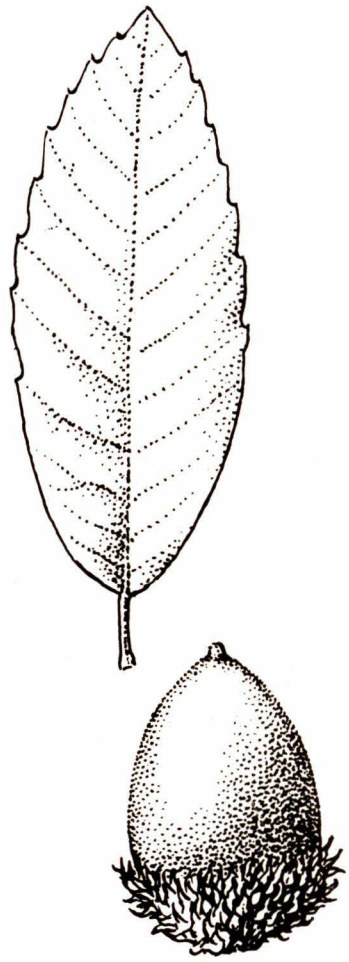
LITHOCARPUS

(tanoaks)

The single species of tanoak (*Lithocarpus*) in California and southwestern Oregon is the only New World representative of this large genus of more than 100 species of broadleaf evergreen trees or shrubs, otherwise confined to subtropical and warm temperate regions of southeastern Asia from Japan and mainland China to Indonesia.

Tanoak has red-brown astringent bark, deeply furrowed into squarish scaly plates, and stout twigs with pale yellow hairs. The buds are clustered at end of twigs and covered with several overlapping scales, the outermost very narrow. The evergreen, alternate, short-petioled leaves are oblong, short-pointed, mostly wavy-toothed, and with many straight side veins.

This intermediate genus has flowers like chestnuts and chinkapins (*Castanea* and *Castanopsis*), with upright spikes of crowded male yellowish flowers or also with 1 to 3 greenish female flowers at base, and acorn fruits like oaks (*Quercus*). The minute flowers are borne in early spring, sometimes also in autumn, mostly from lateral buds (monoecious). The fruit, maturing and falling at the end of the second year, consists of 1 or 2 large acorns on a stalk, with shallow cup covered by long slender, spreading, hairy scales, containing a bitter seed.

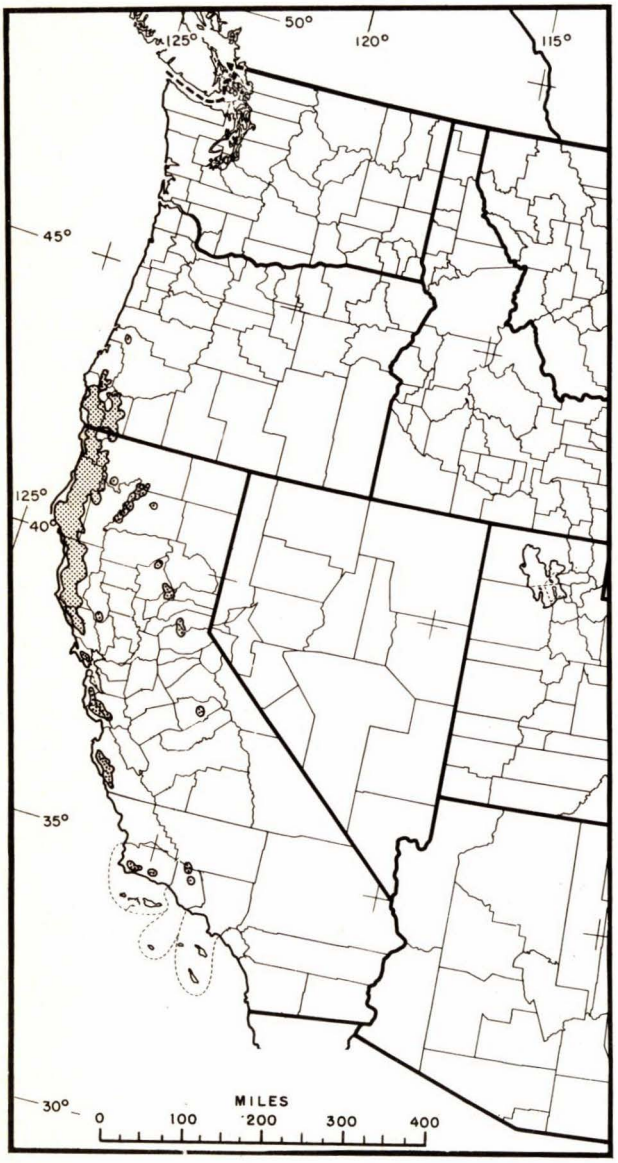


F—462286

TANOAK (*Lithocarpus densiflorus* (Hook. & Arn.) Rehd.)

Other common name: Tanbark oak.

Tanoak is an evergreen hardwood which ranges from slightly north of the Umpqua River in southwestern Oregon southward through the Coast Ranges to the Santa Ynez Mountains north of Santa Barbara, Calif. The range also extends eastward from the Humboldt Bay region to the lower slopes of Mount Shasta, then intermittently southward along the west slope of the Sierra Nevada as far as Mariposa County. In the Sierra, tanoak is most common between the Feather and American Rivers.



The range of tanoak.

733–741 O—65——18

HABITAT CONDITIONS

Climate

Tanoak grows in a climate broadly classified as humid. The annual precipitation, however, is seasonal and varies throughout the natural range from 40 to 100 inches. Summer and early fall are dry and the winter is rainy. Some precipitation falls as snow. The months of June through September usually have less than 1 inch of rain per month. In fact, precipitation during these months amounts to only 5 percent of the year's total. Most of the precipitation, about 70 percent, falls between November and February.

Average mean daily temperatures range from 36° to 42° F. during January and 60° to 74° in July. The last killing frosts in the spring occur between March 8 and April 30; the first killing frosts come between October 20 and November 20. The number of days free of killing frosts range between 160 and 249. Over a 30-year period the maximum temperature recorded at a 600-foot elevation in the center of tanoak's maximum development was 113°; the minimum was 9°.

Soils and Topography

Tanoak grows well on a variety of soils developed from igneous, metamorphic, or sedimentary rocks, or sedimentary rock alluvium. Tanoak is found on serpentine sites which are intermediate between the moist and dry extremes, but is limited to a shrubby form (*18*).[1] It is seldom found on heavy clayey soils.

High-site soils for redwood or Douglas-fir, such as the Hugo, Josephine, Melbourne, Empire, Sites, and Larabee series, are also well suited for the growth of tanoak. These soils have been derived from either consolidated or soft sedimentary rocks. They are light grayish brown or light reddish brown to brown in color and are moderately to strongly acid. Soil textures grade through loam, sandy loam, fine sandy loam, silt loam, to clay loam.

Tanoak also thrives on stony and shallow soil phases where conifers thin out. Yet, for best development tanoak requires more moisture than many other hardwoods. It will grow well on the shallow and stony soils of north slopes, for example, but it will be supplanted by Pacific madrone, Oregon white oak, or California black oak on the warmer, drier south slopes.

[1] Italic numbers in parentheses refer to Literature Cited, p. 272.

Throughout the Coast Ranges from the northern limit of its range (latitude 43° 42′ N.) to the Santa Lucia Mountains (latitude 35° 40′ N.), tanoak grows from sea level to elevations of 4,000 or 5,000 feet. This mountainous area is geologically mature. The terrain is rough, steep, and extremely dissected both by major streams and smaller drainages. In the Santa Ynez Mountains, at the southern limit of its range (latitude 34° 34′ N.), tanoak growns at 2,400 to 4,700 feet. In the northern Sierra Nevada it occurs at 1,900 to 4,000 feet elevation and in the central Sierra at 3,000 to 5,000 feet. At its southern limit in the Sierra, tanoak was discovered between 5,000 and 6,500 feet near Signal Peak (latitude 38° 08′ N.) in the Sierra National Forest.[2]

Tanoak is most abundant and attains its largest size in Humbolt and Mendocino Counties, Calif., between elevations of 500 to 3,000 feet on northerly and easterly slopes and toward the summits of the seaward part of the Coast Range. In the southern Coast Ranges tanoak is common in the Santa Cruz and Santa Lucia Mountains, particularly on the westerly slopes. And in the central Sierra where the climate is less humid it grows in valleys, coves, ravines, along low mountain and foothill streams, and on north slopes.

Associated Trees and Shrubs

Tanoak occurs within the Canadian and the Transition life zones. It is the most abundant hardwood species found in timber stands of the Coast Ranges of California and southwestern Oregon, where it is a component of four forest cover types—Redwood (Type 232), Port-Orford-Cedar—Douglas-Fir (Type 231), Pacific Douglas-Fir (Type 229), and Oak-Madrone (Type 234). It may be a major species in the last type.

In the principal body of tanoak along the inland side of the redwood belt, tanoak sometimes forms almost pure stands. More often it occurs as an understory tree with Douglas-fir or as a component of hardwood stands or of mixed hardwood and conifer forests. The most common hardwood associated with tanoak is Pacific madrone. Other hardwoods occurring more or less commonly with tanoak are bigleaf maple, boxelder, California buckeye, white alder, red alder, golden chinkapin, Pacific dogwood, Oregon ash, California live oak, canyon live oak, California black oak, Oregon white oak, deer oak, willows, and California-laurel (*4*).

Although tanoak is found more often with Douglas-fir, Port-Orford-cedar, and redwood than with other conifers, it also grows with white fir, grand fir, Sitka spruce, knobcone pine, Jeffrey pine, sugar pine, western white pine, ponderosa pine, Pacific yew, western redcedar, California torreya, and western hemlock.

Many shrubs, forbs, grasses, sedges, and ferns also associate with tanoak. Generally these plants are not abundant on forested land, but along with tanoak sprouts, often become aggressive on burned or cutover areas. Among the shrubs are:

Amelanchier alnifolia	western serviceberry
Arctostaphylos canescens	hoary manzanita
A. columbiana	hairy manzanita
A. glandulosa	Eastwood manzanita
Baccharis pilularis	coyote brush
Ceanothus cordulatus	mountain whitehorn
C. foliosus	wavyleaf ceanothus
C. incanus	white thorn
C. integerrimus	deerbrush
C. parryi	lady bloom
C. sorediatus	jimbrush
C. thyrsiflorus	blueblossom
C. velutinus	snowbrush
Corylus rostrata var. *californica*	California hazel
Cytisus scoparius	Scotch broom
Diplacus aurantiacus	brush monkeyflower
Gaultheria shallon	salal
Holodiscus discolor	creambush
Lonicera ciliosa	orange honeysuckle
Myrica californica	Pacific bayberry or waxmyrtle
Photinia arbutifolia	Christmasberry or toyon
Rhamnus californica	coffee berry
R. purshiana	cascara sagrada
Rhododendron macrophyllum	Pacific rhododendron
R. occidentale	western azalea
Rhus diversiloba	poison oak
R. trilobata	squawbush
Ribes cruentum	Blood Sierra gooseberry
R. divaricatum	straggly gooseberry
R. glutinosum	nutmeg currant
R. lobbii	Lobbs or gummy gooseberry
R. menziesii	Menzies or canyon gooseberry
R. sanguineum	flowering currant
Rosa californica	California wild rose
Rubus leucodermis	western raspberry
R. parviflorus	thimbleberry
R. spectabilis	salmonberry
R. vitifolius	California blackberry
Sambucus glauca	blue elderberry
Vaccinium ovatum	California huckleberry
V. parvifolium	red bilberry
Vitis californica	California wild grape

LIFE HISTORY

Reproduction and Early Growth

Flowering and fruiting.—Blossoms may appear in the spring, summer, or autumn. However, most

[2] Wagner, Roy G. File memorandum, S-Supervision, Timberland Acquisition, Redwood Region. U.S. Forest Service, Region 5, 3 pp. Typewritten. February 17, 1937.

tanoaks bloom in June, July, or August. Trees at lower elevations and near the coast bloom earlier than trees at higher elevations and further inland.

The fruit, which is similar to an oak acorn, ripens in the second autumn (*9*). Acorns are usually borne singly, in twos, or in threes, but sometimes more are clustered together (*11*).

Seed production and dissemination.—Tanoak is a prolific seed bearer. In fact, no oak on the Pacific coast produces such large crops of acorns (*10*).

In general, viable seeds are borne in abundance after the thirtieth to fortieth year, although 5-year-old sprouts also have produced fairly heavy crops. Trees are heavily laden almost every alternate year and complete seed crop failures are rare (*17*). When scanty crops occur they are generally caused by frosts or a dry year. However, a long dry period at pollination time is important for setting of acorns. "Jayhawking," peeling the bark from standing trees, often stimulates excessively large acorn crops before the trees die (*7*).

Mature trees produce great numbers of acorns. One estimate of the annual acorn production of a veteran tanoak 30 inches in diameter was about 1,000 pounds (*14*), or about 110,000 acorns. Other estimates showed that trees between 18 and 24 inches in diameter produced 3,900 to 4,600 acorns (*17*).

Insects destroy a significant number of acorns. One study showed insect larvae infesting 51 percent of the acorns. The insects identified were: the filbert weevil (*Curculio uniformis*), the filbertworm (*Melissopus latiferreanus*), and a grey moth similar to *Valentinia glanulella* which was tentatively identified as *Holcocera* sp. (*17*). Other insect larvae which have been found in tanoak acorns are: a cynipid (*Andricus eldoradensis*) and two moths, one a gelechiid and the other a pyralid (*14*).

Mature tanoak acorns are dropped between September 20 and November 15. Many immature acorns are on the ground as early as August 25.

The first acorns to fall usually are insect infested. Those falling later are sound. Indians placed a taboo on collecting acorns for food until their medicine women held a ceremonial festival which celebrated the falling of sound acorns.[3]

Because the acorns are large and heavy, most of them fall straight to the ground and are found under the crowns of the trees. Only a few bounce from lower branches or roll for short distances on steep slopes. In one small study, acorns were counted under trees 18 to 24 inches in diameter at rates of 78,400 to 91,500 per acre (*17*).

[3] Radtke, Leonard B. Notes on the Mast of the Hoopa. United States Department of the Interior Indian Service, 14 pp., 1939.

Seedling development.—Under proper conditions tanoak reproduces well by seed. The acorns germinate readily in sunny, open spots (*8*) if the seedbed is a loose, mineral soil. However, the dense shade of virgin forests and the thick litter found under tanoaks, madrones, or other hardwoods seem to hinder germination. Seedlings are rare in these places (*8*). Tanoak germination is hypogeous.

Acorns may germinate in the fall if the weather is mild. Seed collectors have found that acorns must be planted immediately in light soil. Seedlings appear 3 weeks after planting. To retard germination until spring, acorns must be stratified at a temperature just above freezing.

A count of tanoak seedlings under parent trees left after the Douglas-fir overstory had been cut showed that only 1 seedling grew from 156 sound acorns (*17*). One year's acorn crop produced 160 to 380 seedlings per acre under trees 20 to 26 inches in diameter.

Many animals contribute to the low seed crop efficiency. Although the acorns have hard seedcoats, they are eaten by many birds and mammals such as the California woodpecker, band-tailed pigeon, blue-fronted jay, Pacific varied thrush, Townsend chipmunk, dusky-footed wood rat, Douglas ground squirrel, redwood chickaree, California gray squirrel, American black bear, and Columbia black-tailed deer. Hogs and cattle also prevent seedling reproduction by devouring the acorns and browsing the tender foliage of seedlings.

First-year growth of tanoak seedlings is vigorous. Heights measured from cotyledons to growing tip in one study varied from 1.9 to 8.3 inches and averaged 5.2 inches on July 22. Total first-year growth might have been more. The heights in July, however, were greater than first-year heights of conifers on the same site (*17*).

Tanoak seedlings quickly develop a husky taproot. By the end of July many seedlings have roots penetrating more than 24 inches deep, but although tanoak seedlings grow a deep taproot system, they have difficulty surviving on dry, unprotected slopes.

Best early growth is found where seedlings get partial shade but tanoak is intolerant to heavy shade during its early growth. It becomes more shade-enduring with age (*14*).

In the Trinity River valley and on the low mountain slopes up to 2,000 feet elevation near Salyer, California, tanoak vegetative buds open in mid-April. From 2,000 to 3,500 feet buds burst in mid-May; from 3,500 to 4,400 feet in late May. At its elevational limit, which is about 4,500 feet, buds open in early June. The growing season lasts 4 to 5 months in the mountains and somewhat longer at lower elevations and nearer the coast.

Vegetative reproduction.—Tanoak reproduces

prolifically by vigorous sprouts which appear at practically any time under a wide variety of conditions.[4] Sprouts may start to grow after a relatively minor basal injury, after bark has been stripped from the tree for tannin extraction, or when the aerial parts of the tree are destroyed by fire or logging. Even healthy trees sometimes sprout.

Sprouts develop from conical woody buds which lie under the bark at the base of the tree. Most of these buds are found below the ground line. Since the number of buds varies from few to thousands, the number of sprouts also varies. As many as 1,400 have been counted on one large stump. The only mechanical damage which prevents sprouting occurs when bark is stripped below the ground level and the buds are exposed (*10*).

Sprouts grow rapidly in good light. Measurements show they may grow as tall as 5.6 feet the first year and 13.6 feet in the fifth year. The size of the parent tree determines the height and diameter growth of sprout clumps, and the number of sprouts in a clump. Larger parent trees produce greater sprout development. The living sprouts are reduced drastically in numbers early in their life and growth is concentrated on the dominant stems (table 1) (*15*, *16*). In the first 15 to 20 years sprouts will average about 2 feet in height a year. Often, 4 to 8 slender 30-year-old poles grow around the stump of a parent tree (*7*, *8*). These poles will average 12 to 15 inches in diameter (*5*).

Although not as aggressive as sprouts of some other associated hardwoods, such as bigleaf maple, madrone, and Oregon white oak (*15*), tanoak sprouts are much more important as competitors because tanoak is more abundant, especially in conifer stands. Tanoak sprouts quickly dominate the vegetational cover after logging or fire and often provide severe competition to conifer reproduction. Also the thick, stiff, flat leathery leaves which decay slowly often smother young conifer seedlings or cover the ground so thoroughly that conifer seeds cannot germinate (*4*, *15*, *16*).

Propagation of tanoak by grafting or cuttings has not been reported. European chestnut scions (*Castanea sativa* Mill.) have been grafted on tanoak stumps, however.[5]

Sapling Stage to Maturity

Growth and yield.—The form of tanoak varies greatly. The four general forms are the spire shaped, similar to conifers; the round headed; the shrubby or deep shade form; and the stunted chaparral form. In close stands, particularly dense coniferous forests, tanoaks develop one central trunk, clear for 30 to 80 feet, and a narrow crown with upright branches. In open stands, however, especially in association with Pacific madrone and California black oak, trunks are short and thick, the crowns are broad, the limbs horizontal and large. The main trunk divides into several large branches, forming a rounded crown.

TABLE 1.—*Development in tanoak sprouts on logged or burned forest land in northwestern California*

Time after burning or logging	Sprout clumps measured	Height of tallest sprout in clump		Sprouts per clump	
		Average	Range	Average	Range
Logged:	*No.*	*Ft.*	*Ft.*	*No.*	*No.*
First year	120	2.4	0.7–5.6	16	1–162
Burned:					
Second year	50	5.2	2.2–8.3	27	7–79
Third year	50	6.8	2.2–10.3	12	4–25
Fourth year	50	7.9	2.3–11.3	10	4–25
Fifth year	50	9.3	2.7–13.6	10	4–25
Sixth year	49	10.3	3.5–14.7	9	1–25

Mature trees generally are 50 to 90 feet tall but frequently grow 150 feet high (*9*, *14*). The tallest tree reported was 208 feet high and 4.5 feet in diameter. It was found on the North Fork of the Little Sur River, Monterey County, Calif.[6]

The diameters of mature trees usually vary from 1 to 4 feet. The largest diameter recorded—7 feet 7.9 inches—was measured on a tanoak near Cazadero, Sonoma County, Calif. This tree was 80 feet high and had a crown spread of 84 feet (*1*). Tanoaks with the largest diameters are generally found in open stands where height growth is less. The following tabulation illustrates the diameter-height relationship and the rate of growth (*7*).[7]

Diameter (inches)	*Height (feet)*	*Age (years)*
4–9	30–50	20–40
10–12	40–80	40–100
13–18	80–100	70–125
19–24	90–120	100–159
25–36	115–140	125–180
37–46	100–120	150–210
47–60	100–120	170–250

[4] See footnote 2, p. 268.

[5] Source of information: Mr. "Buck" Zeni, Zeni Ranch, Yorkville-Anchor Bay Road, Mendocino County, Calif., through Paul J. Zinke, School of Forestry, University of California.

[6] Larsen, L. T. File Memorandum. U.S. Forest Serv. Region 5, 1 pp. June 26, 1914.

[7] Bauer, Patricia McCollum. History of lumbering and tanning in Sonoma County, California since 1812. Thesis (M.A.), Univ. of Calif., 189 pp. 1951.

The average age of tanoaks in old growth stands is about 180 years (*5*).

Reaction to competition.—Tanoak is generally rated as tolerant (*2*). It is aggressive and extremely well-fitted by its reproductive habits, vigor, and remarkable shade endurance to compete for possession of the ground (*7*). Although tanoak can endure considerable shade throughout life, it grows best with top light. In conifer stands where it has an equal opportunity to grow, it is able to compete with redwood and Douglas-fir (*7*). In dense stands natural pruning produces long clear boles.

Under stands of dense redwood or Douglas-fir where tanoak obtained a late start, low tanoak shrubs or small trees may be abundant. When the coniferous overstory is removed, the tanoak quickly dominates the logged areas (*7*, *10*). Suppressed trees often develop with remarkable speed after being released from dense shade.

Tanoak is a climax species where it grows in the broad-sclerophyll forest formation which is dominated mainly by sclerophyllus evergreen trees but includes a number of deciduous species. It is successional, however, where its range overlaps those of conifers, and postclimax in its overlap with the climax chaparral (*4*).

Principal enemies.—Fire is the principal enemy of individual tanoak trees. Ground fires, as well as crown fires, are sometimes fatal. More often, however, fires will leave long vertical wounds reaching from 4 to 10 feet up the trunks. Although the bark of mature trees is at least 1 to 3 inches thick, and occasionally 4 or 5 inches, some trees are burned badly (*10*).

Fire injuries to small trees often heal over, but fungi usually enter the wounds on older trees. Sometimes one-third to one-half the diameter of the tree is destroyed as a result of repeated fires and decay.

Until injured by fire, tanoak is relatively free from insects and fungus diseases, and is windfirm. Wind and heavy snows fell many trees originally injured by fire and subsequently weakened by decay. Because of fire and fungi the amount of defect in tanoak may be fairly high.

Fungi found on living trees are the beefsteak fungus (*Fistulina hepatica*), which causes a brown cubical rot; the weeping conk (*Polyporus dryadeus*); a white root rot; and a necrophyte (*Schizophyllum commune*), which causes a sap rot on injured areas of standing trees.

Several insects feed on tanoak but generally are minor in importance. Two of these are armored scales identified as the greedy scale (*Hemiberlesia rapax*) and the oak scale (*Quernaspis quercus*) (*13*). The greedy scale chiefly infests the bark but also occurs on the leaves. The oak scale feeds on the undersides of leaves. Two other insects which resemble the soft unarmored scales also feed on the undersides of leaves. They are the glacial whitefly (*Trialeurodes glacialis*) and the Stanford whitefly (*Tetraleurodes stanfordi*). Ehrhorn's oak scale (*Mycetococcus ehrhorni*) is found on stems and the white sage mealybug (*Pseudococcus crawi*) on stems and leaves.

In 1957 the California oakworm (*Phryganidia californica*) completely destroyed the current year's foliage of tanoaks growing on Hennessey Ridge, near Salyer, Trinity County. This damage was localized and was not observed at other places nearby.

Other insects work under the bark. Adults of a twig girdler (*Agrilus angelicus*) feed on foliage, but its larvae mine spiral galleries which girdle twigs, small limb and trunks, or sprouts. The California oak twig girdler (*Styloxus californicus*), a long-horned beetle or roundheaded borer, also girdles tanoak sprouts.

Tanoak is avoided by livestock unless better feed is unavailable. Columbia black-tailed deer rarely browse it. The current year's growth of tanoak leaves and twigs is covered by a covering of fasicled hairs, which are apparently unpleasant.

SPECIAL FEATURES

The extract from tanoak bark furnishes the best tannage known for the production of heavy leathers (*7*, *8*). The tannin content of tanoak bark varies between 8 and 29 percent (*5*, *12*). Trees must be at least 75 years old before the bark is valuable for its tannin. Trees growing on better sites produce less extract from a given volume of bark than those on poorer sites where growth is slower.[8] The best bark comes from trees growing on ridges, open grown trees, or trees growing in scattered clumps. When grown in dense stands or mixed with other species, tanoak will yield less valuable bark.[9]

Tanoak sapwood is extremely thick, amounting to as much as 66 percent on large trees (*6*). This thick sapwood helps the tree live after the bark has been stripped. Consequently, standing trees sometimes live several years after being peeled, but they never produce a second crop of bark which has commercial value.[10] The root systems of peeled trees which survive probably are fed by sprouts or by other trees through natural root grafts.

[8] See footnote 2, p. 268.

[9] Smith, H. H., Utilization of tanbark oak. U.S. Forest Serv. Calif. Forest and Range Expt. Sta., 1 p. Typewritten. 1950.

[10] Jepson, Willis Linn. The tanbark oak and its relation to the California tanning industry. On file, U.S. Forest Serv. Calif. Forest and Range Expt. Sta., 40 pp. Typewritten. 1910.

The Indians in California's North Coast Range obtained one of their principal foods from the tanoak. In fact, the main fare of many Indian communities was salmon and tanoak acorns. The large acorns were ground, leached, and then prepared as a soup, cooked mush, or kind of bread. After being leached, the acorns are said to have an agreeable acid taste. They also contain a comparatively large amount of oil (*3*, *7*, *14*).

RACES AND HYBRIDS

A shrubby variety of tanoak (*Lithocarpus densiflorus* var. *echinoides* (R. Br.) Abrams) grows near Mount Shasta, on the west slope of the northern Sierra Nevada, in the Salmon and Klamath Mountains, and northward through the Siskiyou Mountains into southern Oregon.[11] This dwarf or mountain variety is part of the chaparral cover found on the mountain tops and ridges. It assumes many of the characteristics of the other chaparral shrubs, such as low stature, ranging from 1 to 10 feet, high, rigid branches, and small, thin leaves (*10*).

There are no known hybrids of tanoak.

Revised from "Silvical Characteristics of Tanoak," by D. F. Roy. U.S. Forest Serv. Calif. [Pacific Southwest] Forest and Range Expt. Sta. Tech. Paper 22, 21 pp. 1957.

LITERATURE CITED

(1) American Forestry Association.
1956. These are the champs, Part II. Amer. Forests 62(4): 33–40.

(2) Baker, Frederick S.
1949. A revised tolerance table. Jour. Forestry 47: 179–181.

(3) Chesnut, V. K.
1902. Plants used by the Indians of Mendocino County, California. U.S. Natl. Mus. Contrib. U.S. Natl. Herbarium 7(3): 295–408.

(4) Cooper, William S.
1922. The broad-sclerophyll vegetation of California—an ecological study of the chaparral and its related communities. Carnegie Inst. Wash., Pub. 319. 124 pp.

(5) Flinn, E. S.
1947. The necessity and feasibility of the commercial development of the California tanbark oak for tannin and wood pulp. Conf. Cult. Drug and Assoc. Econ. Plants in Calif. Proc. 1947: 168–171.

(6) Graham, Robert D.
1954. Seasoning and preservative treatment of tanoak. Jour. Forest Prod. Res. Soc. 4(2): 92–95.

(7) Jepson, Willis Linn.
1910. The silva of California. Calif. Univ., Mem. 2, 480 pp.

(8) ———
1923. The trees of California. Ed. 2, 240 pp. Berkeley, Calif.

(9) ———
1925. A manual of the flowering plants of California. 1238 pp. Berkeley, Calif.

(10) ———, Betts, H. S., and Mell, C. D.
1911. California tanbark oak. U.S. Dept. Agr. Forest Serv. Bul. 75, 34 pp.

(11) Kellogg, A.
1882. Forest trees of California. Calif. State Mining Bur. Bul., 148 pp.

(12) Kidder, Monroe C., and Finney, William H.
1947. California tanbark oak—its immediate availability and possibilities as a source of tannin and wood pulp. Conf. Cult. Drug and Assoc. Econ. Plants in Calif. Proc. 1947: 149–152.

(13) McKenzie, Howard L.
1956. The armored scale insects of California. Calif. Insect Survey Bul. 5: 1–209.

(14) Radtke, Leonard B.
1937. Shall we destroy the tanoaks of the Hoopa Indian Reservation in northern California. U.S. Indian Serv. 25 pp.

(15) Roy, D. F.
1955. Hardwood sprout measurements in northwestern California. U.S. Forest Serv. Calif. [Pacific Southwest] Forest and Range Expt. Sta. Forest Res. Note 95, 6 pp.

(16) ———
1956. Killing tanoak in northwestern California. U.S. Forest Serv. Calif. [Pacific Southwest] Forest and Range Expt. Sta. Forest Res. Note 106, 9 pp.

(17) ———
1957. A record of tanoak acorn and seedling production in northwestern California. U.S. Forest Serv. Calif. [Pacific Southwest] Forest and Range Expt. Sta. Forest Res. Note 124, 6 pp.

(18) Whittaker, R. H.
1954. The ecology of serpentine soils. IV. The vegetational response to serpentine soils. Ecology 35(2): 275–288.

[11] See footnote 7, p. 270.
See footnote 2, p. 268.